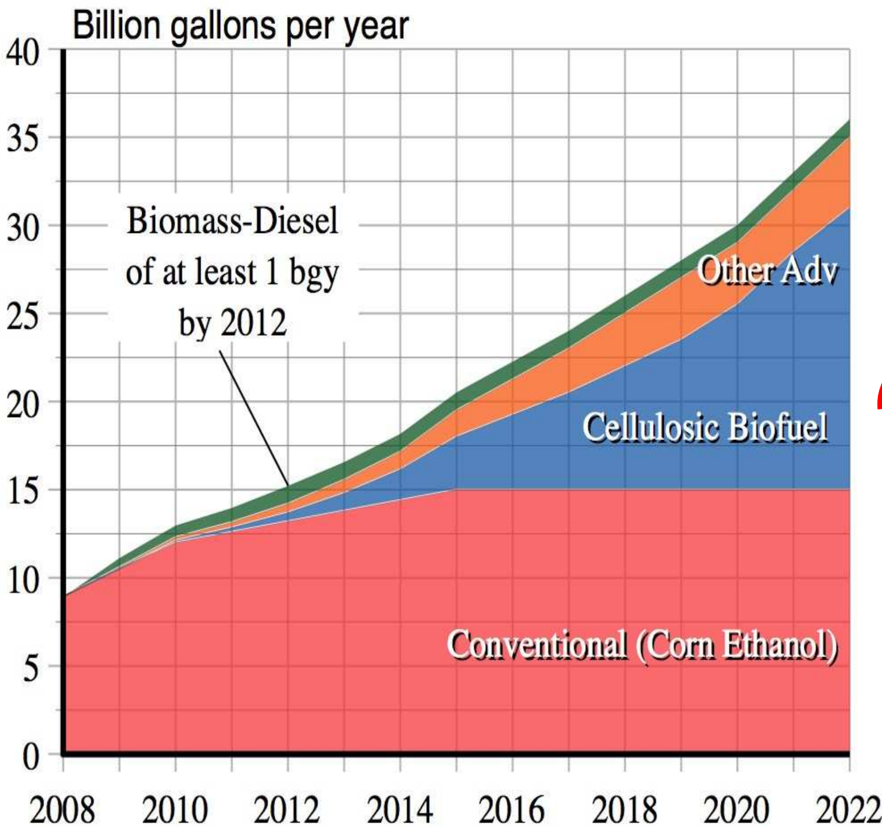
Modeling soil quality Potential soil effects of biomass production and removal, and RFS-2 feedstocks

Richard Nelson

Kansas State University

RFS – 2 Volumetric Requirements and Sustainability Criterion



Fuel Type	Sustainability Criterion
Conventional Biofuel Ethanol from Corn Starch	20% lifecycle greenhouse gas emission reduction
Advanced Biofuels Anything but corn ethanol, including the following subcategories	50% lifecycle greenhouse gas emission reduction
Bio-based Diesel A Biomass based diesel fuel substitute	50% lifecycle greenhouse gas emission reduction
Cellulosic Biofuels Renewable fuel produced from cellulose, hemicellulose, or lignin	60% lifecycle greenhouse gas emission reduction

Plant-Derived Liquid Fuels - Four Options

Liquid Fuels by Feedstock and Land Capability Class

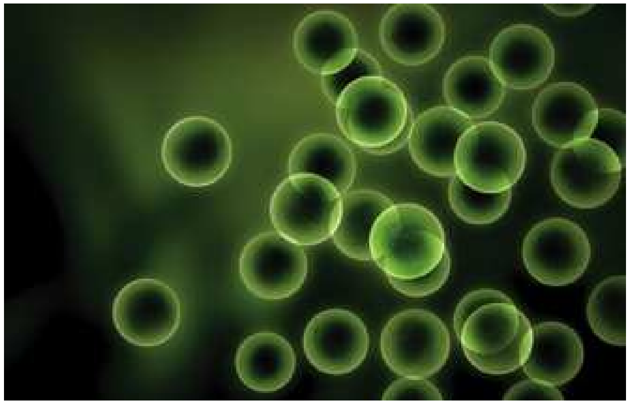
	Arable Lands	Non-arable Lands
Starch and Cellulose-based	Ethanol from Grain Ethanol from Crop Residues	Cellulosic Ethanol from Perennials (herbaceous and woody)
Lipid-based	Biodiesel from Annual Oilseeds	Biodiesel from Perennial Oilseeds

Major Ethanol Feedstocks

Which lands and how they are managed (or should be) will be of paramount importance

Biodiesel Feedstocks

Brassica Juncea



Agricultural Crop Residue Removal

Residue Required for Erosion Control is a function of:

1. **Type of Erosion (wind or rainfall (water))**
2. **Field management practices (tillage)**
3. **Soil type**
4. **Climate (rainfall, temperature, retained moisture)**
5. **Physical field characteristics (% slope, soil erodibility)**
6. **Crop and cropping rotation**
7. **Tolerable Soil Loss, T**
8. **Grain yield (bu/ac)**

<u>**Tolerable Soil Loss, T**</u>

Maximum rate of soil erosion that will <u>not</u> lead to prolonged soil deterioration and/or loss of productivity

Been in place for decades as the soil sustainability metric

National Ag Crop Residue Removal Project

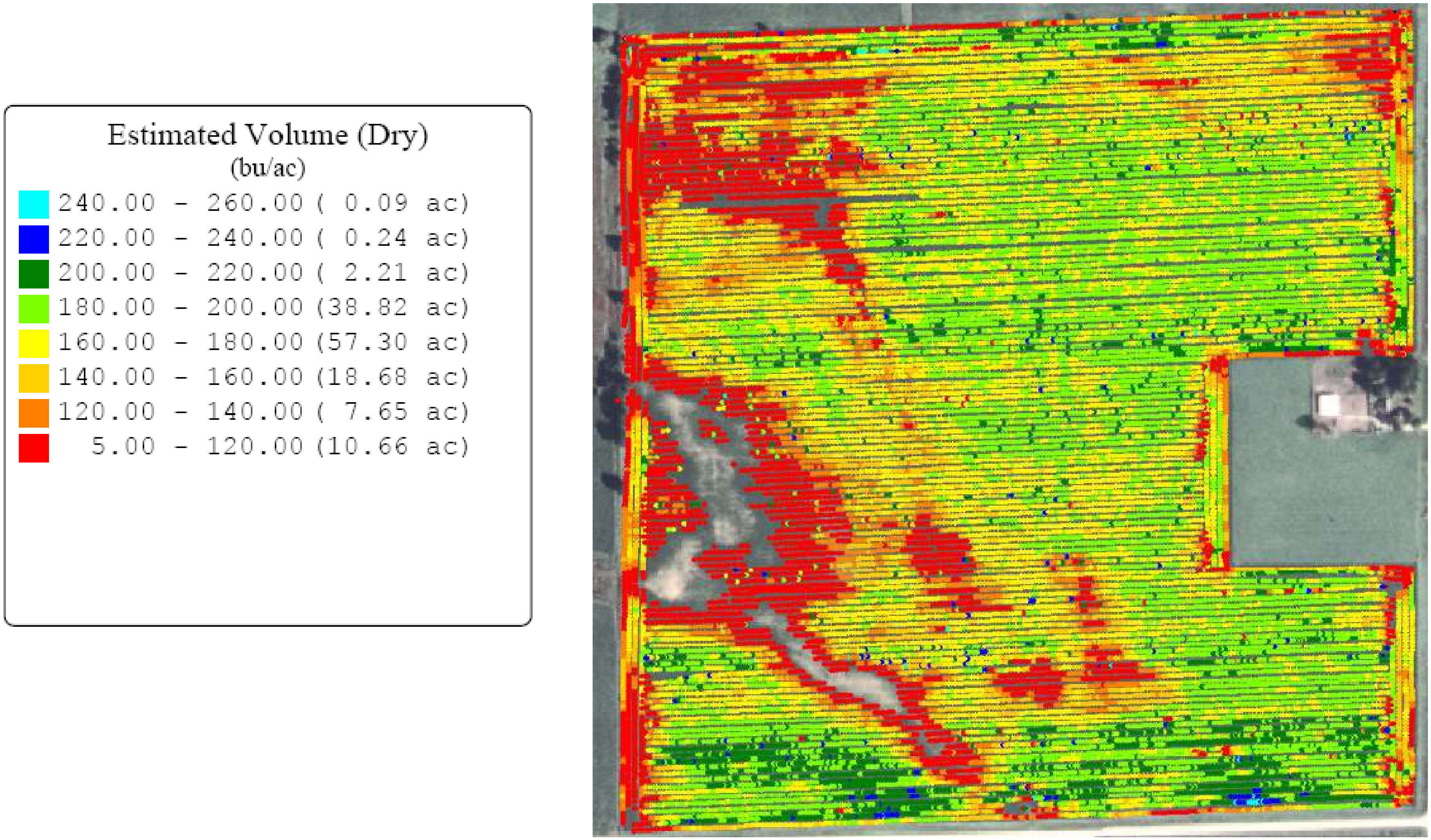
- Major part of US DOE's Billion Ton Study
- Collaboration with Idaho National Lab and others
- Corn and sorghum stover and small-grain straws (wheat, barley, oats) residues examined for sustainable removal

New approach employed

Use RUSLE2 & WEPS with 1, 2, and/or 3-year cropping rotations per county

- Run "baseline" erosion & soil carbon for every SSURGO soil type
- Run residue removal for applicable corn and wheat rotations based on moderate, moderately high, and high levels of residue harvest removal

Variable Rate Harvest



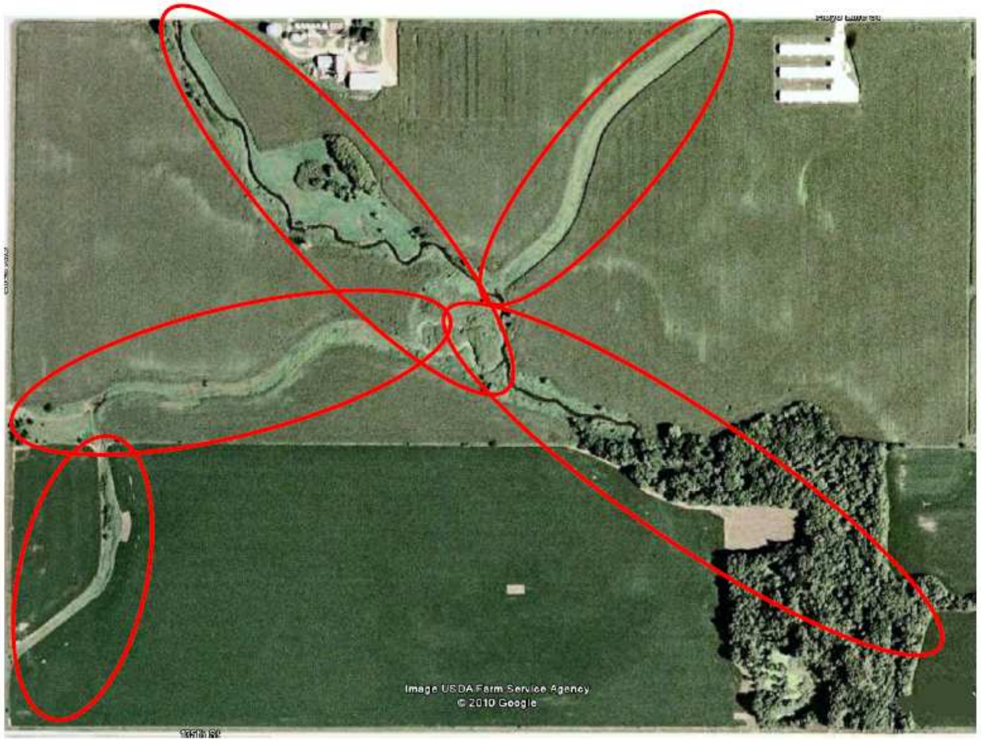
Marginal Lands, Economic Return, and Environmental Quality

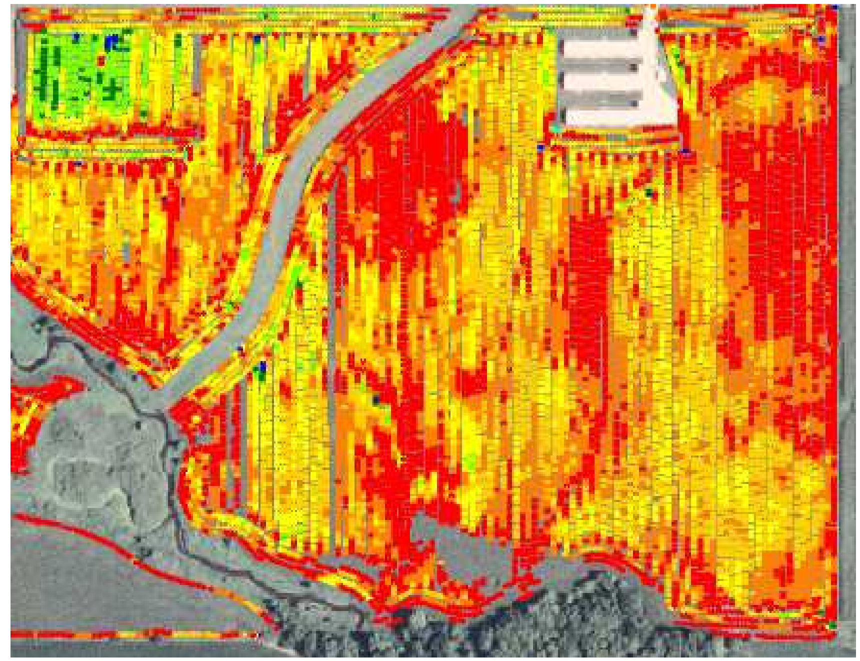
Minimal Cover - Exposure to Wind/Rainfall Erosion;

Possible improvement with alternate cropping scenarios.

Is $5 - $15 per acre the best we can do for this land or does bioenergy production offer a more 'sustainable means' for the Kansas landowner?

Entry Points for Dedicated Energy Crops





Estimated Volume (Dry)
(bu/ac)

240.00 - 260.00	(0.03 ac)
220.00 - 240.00	(0.12 ac)
200.00 - 220.00	(0.57 ac)
180.00 - 200.00	(3.28 ac)
160.00 - 180.00	(15.31 ac)
140.00 - 160.00	(36.01 ac)
120.00 - 140.00	(32.81 ac)
5.00 - 120.00	(39.32 ac)

Land Capability Class Utilization – Marginal Lands

Reno County KS		# of Acres by Land Capability Class (LCC)					
	Acres	1	2	3	4	5	6
Open water	15,176						
Developed, Open Space	37,579						
Developed, Low Intensity	11,938						
Developed, Medium Intensity	2,269						
Developed, High Intensity	1,110						
Barren Land	125						
Deciduous Forest	19,716						
Evergreen Forest	12						
Mixed Forest	1						
Scrub/Shrub	175		52	52	19	28	26
Grassland/Herbaceous	299,960	3,502	93,911	98,891	31,023	23,478	47,936
Pasture/Hay	2,662	930	881	455	398	0	0
Cultivated Crops	415,866	30,851	208,943	143,700	25,668	3,650	2,723

What is the "environmental holding capacity" of these lands for biofuel purposes and possible economic returns by crop?

Decreasing Land Capability = Increasing EI

Brassica Juncea

- Canola like oil quality
  - 40% oil content
- Can be grown in low rainfall areas (~8 inches)
  - 800 to 1,000 lb yields per acre
- Meal suitable for livestock feed
- Varieties available
- Potential for 2 to 4 million acres in the U.S. and Canada
- Market?

Brassica Juncea

Biomass-based Diesel

- 1 BGY by 2012+ for RFS-2
- In 2009, ~1% of the soybean crop by weight was used for biodiesel – % will probably will continue in the future or even go down
- This provides no leverage for certification or environmental practices of farms producing food crops or the commodity market. Also, by the time the oil from a soybean crop gets to the producer, there is literally no way the two can be matched.
- The 1 % is well within the “white noise” of geo-climatic variation in yields within a single county to be essentially impractical
- In some cases/times, the combined stocks of oils or fats may be enough to provide needed feedstock

Soils and the RFS-2

- Soil and sustaining its quality is everything to a farmer/landowner

- Farming is becoming less “intense” and much more precise due to a number of factors related to the commodity market and variations within a market

- Timeframe for farmers is long-term with respect to sustainability; prices unknown and out of their control, but field/soil quality they can control

Factors that will Influence Biomass/Feedstock Availability

- Much is unknown at this point (more than known)
- Crop Yields – Yields in all crops will continue to improve – implications for residue removal (probably will have to remove)
- Definitions of “marginal” lands and productivity measures
  - Environmental quality needs to get into the analysis
- Land Use for Biofuel Production – possible environmental quality increases with biofuel crops
  - Sweet sorghum, Camelina
- Water supply and efficient utilization